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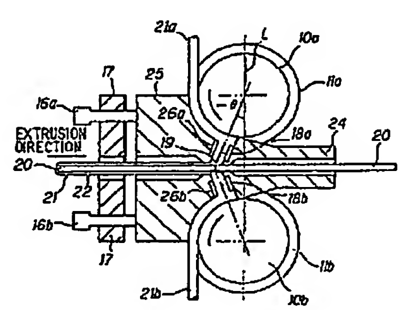
(54) Method and apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus.

(57) A two wheel type continuous extrusion apparatus is provided with covering material inlet apertures (18a,18b) for communicating passage-ways to a covering chamber for extruding covering material (21a,21b) on a core metal wire (20) to manufacture a composite metal wire (22).

The covering material inlet apertures (18a,18b) are inclined relatively to a line (L) connecting rotary axes of the rotary wheels (10a,10b), such that the covering chamber (19) is positioned on the side of supplying the covering material rods (21a,21b) relative to the line (L). Consequently, a constraining force for constraining a shoe block (25) becomes small.

FIG.3



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The invention relates to a method and an apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, and more particularly to, the improvement in which the position of covering material inlet apertures is optimized.

A conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus comprises two rotary wheels each having a groove on the outer periphery provided symmetrically relative to an extruding direction of the composite metal wire, a fixed shoe block having arc-edge surface for closing partially the grooves of the rotary wheels to provide two passage -ways, a nipple having an aperture through which a core metal wire is supplied, two position-changeable abutments each pressed into the groove of a corresponding rotary wheel to close the passage-way, and two adjusting bolts each adjusting a contact pressure of a corresponding abutment to the corresponding rotary wheel, wherein the shoe block is provided with a die which is positioned on the side of extruding the composite metal wire in a covering chamber which is defined between the die and the nipple and communicates with the two passage-ways.

In operation, two aluminium rods are supplied into the two passage-ways, respectively, while the two rotary wheels are rotated to apply drug force to the two aluminium rods, so that the plasticized aluminium is interrupted to be supplied to the covering chamber by the abutments, in which a steel core wire supplied from the nipple is coated with the plasticized aluminium to be extruded from the die.

Thus, a composite metal wire having the steel core wire coated with a covering layer of aluminium is manufactured by using the two wheel type continuous extrusion apparatus.

In this two wheel type continuous extrusion apparatus, the covering chamber is connected via covering material inlet apertures to the passage-ways, wherein the covering material inlet apertures are provided vertical to the extrusion direction of the composite metal wire to be positioned on a line connecting rotary axes of the rotary wheels.

In another conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, a covering wheel type continuous extrusion apparatus, a covering chamber is provided on the opposite side of supplying covering material rods relative to a fine connecting rotary axes of the rotary wheels, such that covering material inlet apertures are inclined relatively to the extrusion direction of the composite metal wire. In addition, the combination of abutments and a nipple is replaced by an abutment which is formed with a nipple in an integral manner.

According to the former conventional apparatus for manufacturing a composite metal wire, however, there is a disadvantage in that the burr formation is difficult to be suppressed in amount, when it is increased due to the abrasion, the deformation, etc. of parts of the apparatus such as the rotary wheels, because the position change of the abutments is small to result in unsufficient adjustment not to provide a predetermined seal effect between the grooves of the rotary wheels and the abutments. Consequently, the parts must be replaced earlier by new ones. This results in trouble-some and more frequent disassembling operation of the fixed shoe block, the position-changeable abutments, etc. Further, there is a disadvantage in that the dimension precision of the parts which is required to manufacture a composite metal wire having a predetermined precision is ought by experiments, so that it takes a long time to adjust the apparatus appropriately. Still further, there is a disadvantage in that a pull-in force (a horizontal component force) of the fixed shoe block caused by the rotation of the rotary wheels is directly applied to the adjusting bolts and a support block for supporting the adjusting bolts, so that the mechanical strength of the support block must be large.

On the other hand, the latter conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus is more practical than the former conventional one, because the sealing contact pressure is easily adjusted therein, for the reason that the two-divided abutments are largely changed in position, and because the dimension precision of the parts is relieved to some extent. However, there is a disadvantage in that a force for sustaining the abutments must be large, because the covering material inlet apertures are inclined on the opposite side of supplying covering material rods relatively to the rotary axis connecting line of the rotary wheels. Further there is a disadvantage in that an apparatus cost becomes high, because the total configuration of the fixed shoe block and the abutments becomes large in an integral block, and is therefore divided to be assembled by two sections. As a matter of course, the assembling and disassembling operation of the two-divided sections is required to result in the necessity of a longer time and skilled workers.

Accordingly, it is an object of the invention is to provide a method and an apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus in which a seal contact pressure is easily adjusted between each groove of rotary wheels and each pressure surface of abutment portions.

It is a further object of the invention to provide a method and an apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus in which the dimension precision of parts is relieved.

It is a still further object of the invention to provide a method and an apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus in which handling operation in assembling and disassembling the apparatus is made easier.

According to a feature of the invention, a method for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, comprises the steps of :

providing two rotary wheels each having an endless groove on an outer periphery thereof;

providing a fixed shoe block having two portions facing said grooves of said two rotary wheels to define two passage-ways and a die for extruding said composite metal wire;

providing an abutment block having two portions for closing said two passage-ways and a nipple for supplying a core metal wire;

defining two covering material inlet apertures communicated with said two passage-ways between said fixed shoe block and said abutment block, and a covering chamber including said die and said nipple and being communicated with said two covering material inlet apertures

rotating said two rotary wheels in predetermined opposite directions by a predetermined speed ;

supplying two covering material rods to said two passage-ways to be plasticized therein by a pressure increase and said core metal wire through said nipple to said covering chamber to extrude said composite metal wire from said die, said composite metal wire comprising said core metal wire and a covering material layer extruded on said core metal wire in accordance with plasticized deformation of said covering material rods; and

generating a pull-in force of said fixed shoe block, and a reaction force resulted from a power of said two rotary wheels equivalent to an extrusion pressure by said rotating of said two rotary wheels;

wherein a horizontal component of said pull-in force is reverse in vector to a horizontal component of said reaction force.

According to another feature of the invention, an apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, comprises:

two rotary wheels each having an endless groove on an outer periphery to be provided symmetrically in a direction of extruding said composite metal wire;

a fixed shoe block having two portions facing said two grooves of said two rotary wheels to define two passage-ways and a die for extruding said composite metal wire, covering material rods being supplied to said two passage-ways ;

an abutment block having two portions for closing said two passage-ways and a nipple for supplying said core metal wire ; and

two covering material inlet apertures defined between said fixed shoe block and said abutment block to communicate said two passage-ways to a covering chamber including said nipple and said die ;

wherein said two covering material inlet apertures are inclined relatively to a line connecting rotary axes of said two rotary wheels by a predetermined angle, thereby providing said covering chamber to be positioned on a side of supplying covering material rods relative to said line.

The invention will be described in more detail in conjunction with appended drawings, wherein:

Fig.1 is a cross sectional view showing a first conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus;

Fig.2 is a cross sectional view showing a second conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus;

Fig.3 is a cross-sectional view showing an apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus of a preferred embodiment according to the invention;

Fig. 4 is a cross sectional view showing an enlarged main portion of the preferred apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus;

Figs. 5A to 5D are vector diagrams showing each force acting in the preferred apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus; and

Fig. 6 is a graph explaining a relation between an angle of covering material inlet apertures and each acting force in the preferred apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus.

Before explaining an apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus of a preferred embodiment according to the invention, the aforementioned conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus will be explained in Figs. 1 and 2.

Fig. 1 shows the first conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus which comprises rotary wheels 10a and 10b having grooves 11a and 11b on the outer peripheries, a fixed shoe block 12 having a die 13 provided to define passage-ways along portions of the grooves 11a and 11b of the rotary wheels 10a and 10b, abutments 14a and 14b for closing the passage-ways in accordance with the pressure contact to the rotary wheel grooves 11a and 11b, a nipple 15 through which a core metal wire 20 is supplied, a support block 17 for constraining the abutments 14a and 14b, and bolts 16a and 16b for adjusting the position of the abutments 16a and 16b. In this apparatus, covering material inlet apertures 18a and 18b and a covering chamber 19 are defined between the fixed shoe block 12 and the nipple 15, such that they are positioned on a line L which connects rotary axes of the rotary wheels 10a and 10b.

In manufacturing a composite metal wire 22, covering material rods (for instance, aluminium) 21a and 21b are supplied along the rotary wheel grooves 11a and 11b via the passage-ways and the covering material inlet aperatures 18a and 18b to the covering chamber 19, in which the plasticized covering material applies pressure on the outer surface of the core metal wire (for instance, steel) 20, so that a composite metal wire 22 is extruded from the die 18. In this apparatus, the seal contact pressure of the abutments 14a and 14b on the inner surfaces of the rotary wheel grooves 11a and 11b is adjusted in accordance with the position shift of the abutments 14a and 14b carried out in the extrusion direction and the reverse direction thereof by the bolts 16a and 16b.

Fig.2 shows the second conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, wherein like parts are indicated by like reference numerals as used in Fig. 1.

In this apparatus, covering material inlet apertures 18a and 18b are provided to be inclined relatively to a rotary axis connecting line L by an angle θ, such that a covering chamber 19 is positioned on the opposite side of supplying the covering material rods 21a and 21b relative to the connecting line L. In addition, a nipple 15 is defined by an abutment 23, such that the horizontal position shift of the abutment 23 may be different in amount therebetween to adjust not only a horizontal pressure but also a vertical pressure.

In accordance with the first and second conventional apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, however, the aforementioned disadvantages are resulted.

Next, an apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus of a preferred embodiment according to the invention will be explained in Fig. 3, wherein like parts are indicated by like reference numerals as used in Figs. 1 and 2.

In this preferred apparatus, covering material inlet apertures 18a and 18b are provided to be inclined relatively to a rotary wheel axis connecting line L in the opposite direction to that in Fig. 2 by an angle-θ, such that a covering chamber 19 is positioned on the side of supplying the covering material rods 21a and 21b relative to the connecting line L. In addition, the support block 17 is provided to adjust the position of fixed shoe block 25 by using bolts 16a and 16b, and heat proof alloy ring members 26a and 26b are provided on the inner surface of the covering material inlet apertures 18a and 18b. The shoe block 25 and the abutment block 24 are preferable to be one integral block.

Next, various forces acting on parts of the apparatus for manufacturing the composite metal wire 22 by using a two wheel type continuous extrusion apparatus will be explained. In Fig. 4, a pull-in force F_1 for pulling the fixed shoe block 25 into the vector direction in accordance with the rotation of the rotary wheel 10a, and a reaction force F_2 caused by a power (extrusion force) of the rotary wheel 10a are shown.

The relation of the forces F_1 and F_2 and a constraining force F_0 for constraining the fixed shoe block 25 will be explained in Figs. 5A to 5D, wherein each vector is shown to be positive in the direction opposite to the extrusion direction and negative in the extrusion direction.

The constraining force F_0 has the same magnitude as a combined force of a vertical component f_1 of the pull-in force F_1 and that of the reaction force F_2, and a reversely directional vector relative to the direction of the combined force. If it is assumed that the pull-in force F_2 and the reaction force F_2 have vectors as shown in Figs. 5A and 5B, the constraining forces F_0 will be a negative value as shown in Fig. 5C or a positive value as shown in Fig. 5D.

Fig.6 shows a force F acting in the horizontal direction relative to an angle θ with which the covering material inlet aperture 18a is defined relatively to the connecting line L, wherein the force F is positive in the extrusion direction, and the angle θ is positive in the counter-clockwise direction, so that the angle θ is negative in the preferred embodiment.

As understood from the curves represented in Fig. 6, the horizontal component f_1 of the pull-in force F_1 acts constantly in the positive direction regardless of the defined angle θ of the covering material inlet

aperture 18a, and is the maximum value in the vicinity of the angle $\theta(=0°)$, and the horizontal component f_2 of the reaction force F_2 is approximately negative in the region where the angle θ is negative, and positive in the region where the angle θ is positive, wherein the absolute value thereof is proportional to the absolute value of the angle θ.

The constraining force F_0 which is the combined force of the horizontal forces f_1 and f_2 becomes zero at a predetermined negative angle θ_c, while it becomes a negative value on the negative side of the angle θ_c, and a positive value on the positive side thereof. Even worse, the constraining force F_0 becomes large as the angle θ is increased in the positive direction. For this reason, the angle θ is set to be approximately the angle θ_c in the preferred embodiment, so that the constraining force F_0 becomes zero or a relatively small value to make the position shift of the fixed shoe block 25 possible by a small external force. As a matter of course, a minute position adjustment can be also made easily. When the angle θ is on the negative side of the angle θ_c , the combined force is negative, while the constraining force F_0 is positive, so that the position adjustment of the fixed shoe block 25 can be carried by an external force applied in the direction opposite to the extrusion direction.

In manufacturing the composite metal wire 22 in which the steel core wire 20 is covered with the aluminium covering layer 21, it is assumed in a first instance that the angle θ is -25°, that is, the covering material inlet apertures 18a and 18b are provided to be inclined on the side of supplying the covering material rods 21a and 21b relative to the connecting line L by 25°. In this instance, the constraining force F_0 is measured to be approximately 5 tons. On the other hand, the constraining force F_0 is obtained to be 40 tons in the conventional apparatus as shown in Fig.1, wherein each 20 tons are required for the abutments 14a and 14b. As apparent from the comparison of these measured constraining forces F_0, the constraining force F_0 is much decreased in the invention.

When the negative angle θ becomes larger in absolute value than the above specified angle, a horizontal component f_1 of the pull-in force F_1 is always smaller than a horizontal component f_2 of the reaction force F_2, so that a required constraining force F_0 is always reverse to the extrusion direction. As a result, no constraining means is required on the side of supplying a core metal wire 20, and a support mechanism for constraining the fixed shoe block 25 (which may be integral with the abutment 24) is only provided on the side of extruding a composite metal wire 22. Accordingly, the position adjustment of the fixed shoe block 25, and the pressure adjustment of the abutment 24 on the grooves 11a and 11b of the rotary wheels 10a and 10b becomes extremely easy.

In this preferred embodiment, the heat-proof alloy rings 26a and 26b are provided on the inner surfaces of the covering material inlet apertures 18a and 18b, so that they are protected thereby from abrasion and deterioration caused by high temperature which is generated by abrasion with the covering material rods 21a and 21b in the passage-ways defined between the rotary wheels 10a and 10b and the fixed shoe block 25. The heat-proof alloy rings 26a and 26b may made of, for instance, Inconel (Trademark) which is one of nickel based heat-proof alloys.

In the invention, a composite metal wire may be modified in material and construction. For instance, a core metal wire may be in construction of a metal wire having an axial bore, a stranded wire, a wire having gaps, a wire insulated by a continuous insulation, or a non-continuous insulation, etc.

As a second instance of the preferred embodiment, the angle θ is set to be -15° for the covering material inlet apertures 18a and 18b, through which aluminium is supplied to the covering chamber 19 to manufacture a composite metal wire 22 having a steel wire 20 and an aluminium covering layer 21. In this instance, the following parameters are adopted.

PARAMETER	EXAMPLE1	EXAMPLE2
ROTARY WHEEL OUTER DIAMETER	ø 440mm	ø 440mm
ALUMINIUM COVERING MATERIAL ROD DIAMETER	ø 9.5mm	ø 9.5mm
STEEL CORE WIRE DIAMETER	ø 6.6mm	ø 2.1mm
ALUMINIUM COVERED COMPOSITE WIRE DIAMETER	ø 7.6mm	ø 3.4mm
ALUMINIUM COVERING LAYER THICKNESS	0.5mm	0.65mm
ROTARY WHEEL REVOLUTION NUMBER	7.3rpm	5.5rpm
STEEL CORE WIRE PRE-HEAT TEMPERATURE	400°C	400°C
STEEL CORE WIRE FRONT TENSION	2,000kg	350kg
YIELD OF ALUMINIUM COVERING MATERIAL	95%	93%

As apparent from the above table, the steel core wire 20 is pre-heated prior to the supply to the covering chamber 19, and is applied with a front tension which is generated, for instance , by a winding drum which is installed at a stage following the two wheel type continuous extrusion apparatus.

Consequently, the yield of the aluminium covering material is 95% in the Example 1, and 93% in the Example 2. This means that the yield is largely improved in the invention as compared to the conventional apparatus as shown in Fig.1 in which the yield is approximately 80 to 85%.

In the modification of the apparatus as shown in Fig.3, the abutment block 24 may have a die, and the shoe block may have a nipple, so that the extrusion direction becomes reverse.

The horizontal force components f_1 and f_2 referred to herein are the components of F_1 and F_2 parallel to the direction of wire feed and extrusion direction.

Claims

1. A method for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, comprising the steps of :

    providing two rotary wheels each having an endless groove on an outer periphery thereof;

    providing a fixed shoe block having two portions facing said grooves of said two rotary wheels to define two passage-ways and a die for extruding said composite metal wire;

    providing an abutment block having two portions for closing said two passage-ways and a nipple for supplying a core metal wire;

    defining two covering material inlet apertures communicated with said two passage-ways and a covering chamber including said die and said nipple and being communicated with said two covering material inlet apertures between said fixed shoe block and said abutment block ;

    rotating said two rotary wheels in predetermined opposite directions by a predetermined direction ;

    supplying two covering material rods to said two passage-ways to be plasticized therein by a pressure increase and said core metal wire through said nipple to said covering chamber to extrude said composite metal wire from said die, said composite metal wire comprising said core metal wire and a covering material layer extruded on said core metal wire in accordance with plasticized deformation of said covering material rods; and

    generating a pull-in force of said fixed shoe block and a reaction force resulted from a power of said two rotary wheels equivalent to an extrusion pressure by said rotating of said two rotary wheels;

    wherein a horizontal component of said pull-in force is reverse in vector to a horizontal component of said reaction force.

2. A method for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, according to claim1, wherein :

    said generating step, comprises:

    supplying plasticized covering material from said two passage-ways through said two covering material inlet apertures to said covering chamber by a predetermined angle relative to a line connecting rotary axes of said two rotary wheels, said predetermined angle designating a point on a side of supplying said covering material rods relative to said line.

3. An apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, comprising:

    two rotary wheels each having an endless groove on an outer periphery to be provided symmetrically in a direction of extruding acid composite metal wire;

    a fixed shoe block having two portions facing said two grooves of said two rotary wheels to define two passage-ways and a die for extruding said composite metal wire, covering material rods being supplied, in use, to said two passage-ways ;

    an abutment block having two portions for closing said two passage-ways and a nipple for supplying said core metal wire ; and

    two covering material inlet apertures defined between said fixed shoe block and said abutment block to communicate said two passage-ways to a covering chamber including said nipple and said die ;

    wherein said two covering material inlet apertures are inclined relatively to a line connecting rotary axes of said two rotary wheels by a predetermined angle, thereby providing said covering chamber to be positioned on a side of supplying said covering material rods relative to said line.

4. An apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, according to claim 3, further comprising :
a support block for constraining said fixed shoe block against a constraining force resulted from a difference between a horizontal component of a pull-in force of said fixed shoe block generated by rotation of said two rotary wheels and a horizontal component of a reaction force generated by a power of said two rotary wheels equivalent to an extrusion pressure.

5. An apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, according to claim 4, wherein :
said predetermined angle of said two covering material inlet apertures is determined to generate said constraining force acting in a direction of extruding said composite metal wire, and said support block is provided on a side of supplying said covering material rods relative to said fixed shoe block.

6. An apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, according to claim 5, wherein :
said predetermined angle is an angle in absolute value ranging 10 to 40° relative to said line.

7. An apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, according to claim 5, wherein :
said fixed shoe block and said abutment block are structured to be integral as one block.

8. An apparatus for manufacturing a composite metal wire by using a two wheel type continuous extrusion apparatus, according to claim 5, wherein :
said covering material inlet apertures are covered on inner surfaces with super heat-proof alloy layers.

FIG.1 PRIOR ART

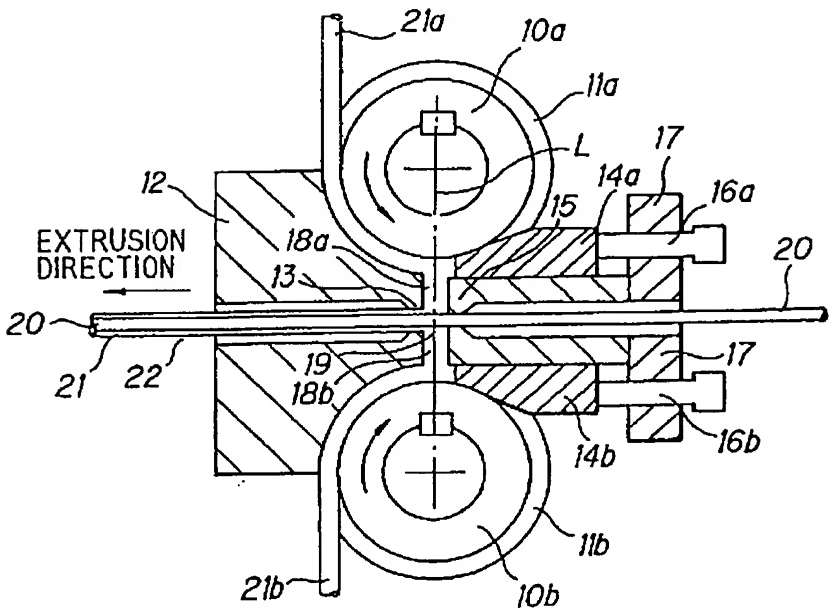
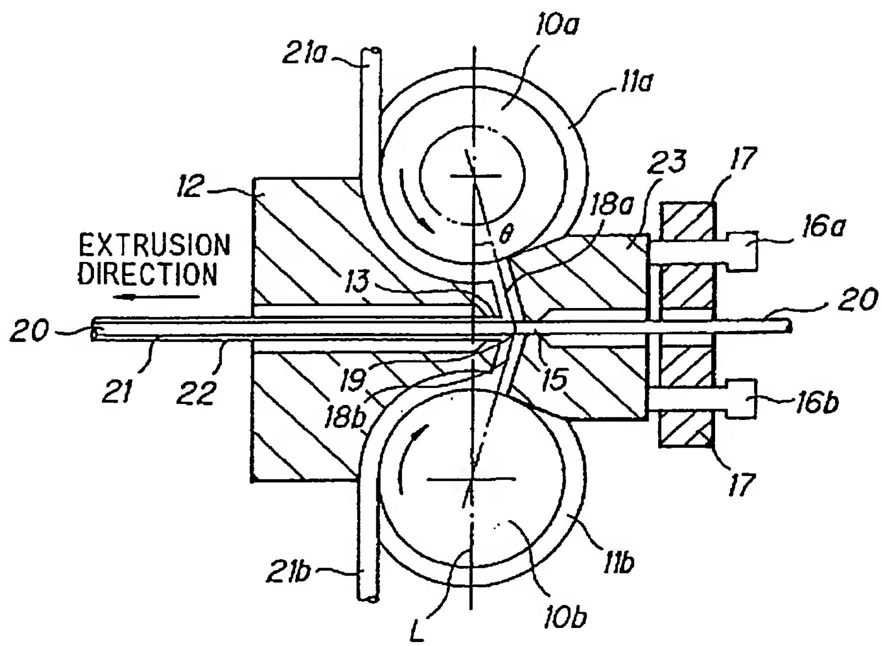


FIG.2 PRIOR ART



F I G . 3

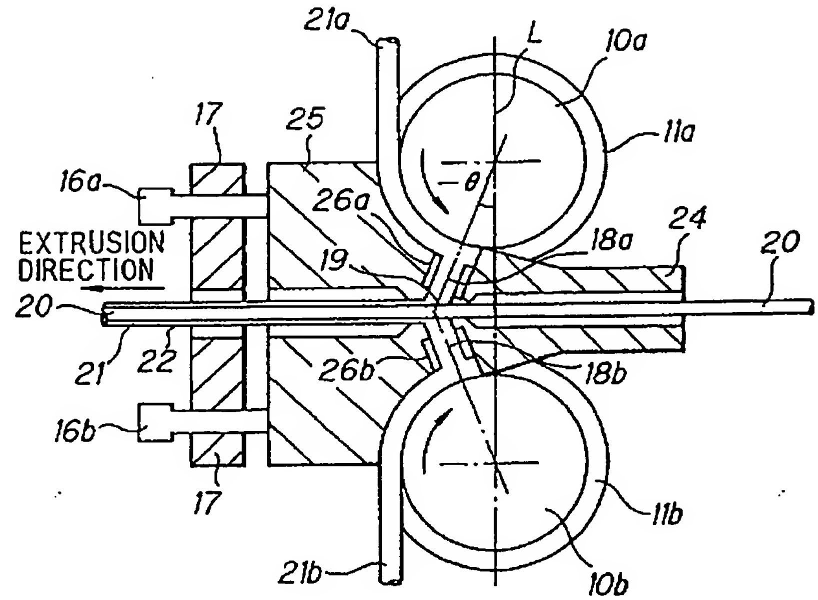

21a
L
10a
17
25
11a
16a
θ
26a
24
EXTRUSION DIRECTION
18a
20
19
20
21
22
26b
18b
16b
11b
17
21b
10b

FIG.4

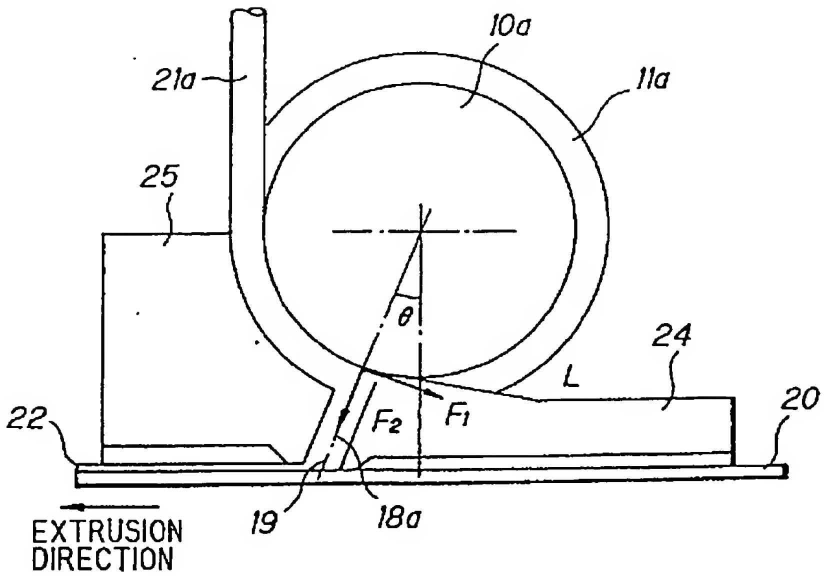


FIG.5A

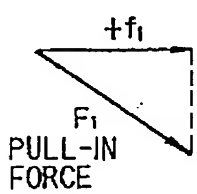


FIG.5B

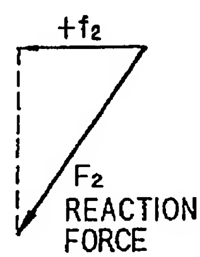


FIG.5C

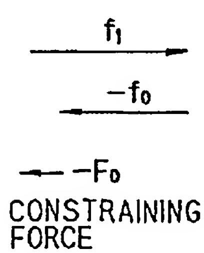


FIG.5D

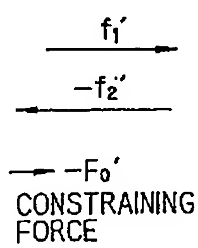
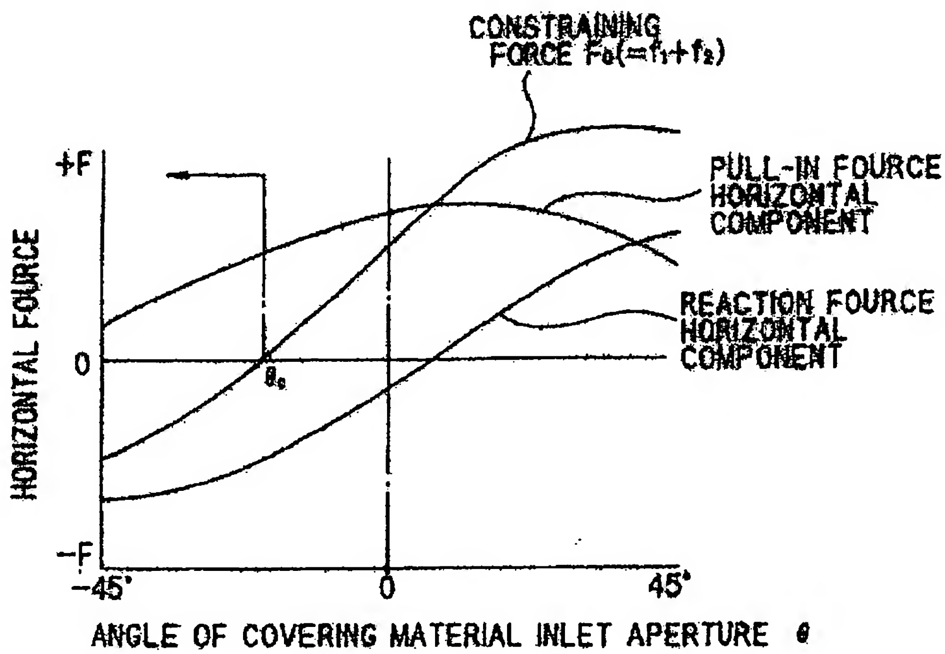


FIG. 6


CONSTRAINING FORCE $F_0(=f_1+f_2)$
PULL-IN FOURCE HORIZONTAL COMPONENT
REACTION FOURCE HORIZONTAL COMPONENT
+F
0
−F
HORIZONTAL FOURCE
θ_0
−45°
0
45°
ANGLE OF COVERING MATERIAL INLET APERTURE θ

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 31 0631

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X Y	US-A-5 000 025 (BEEKEL) * column 2, line 17 - line 32 * * column 3, line 30 - column 4, line 52 * * column 6, line 11 - column 7, line 4; figures 1,3,9 *	1-6 7	B21C23/24 B21C23/00 B21C23/30
A	GB-A-2 081 153 (ALFORM ALLOYS LTD) * page 3, line 49 - line 65; figures 1,5 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 176 (M-398)(1899) 20 July 1985 & JP-A-60 46 810 (HITACHI DENSEN KK) 13 March 1985 * abstract *	1	
Y	PATENT ABSTRACTS OF JAPAN vol. 9, no. 87 (M-372)(1810) 17 April 1985 & JP-A-59 215 211 (SUMITOMO DENKI KOGYO KK) 5 December 1984 * abstract *	7	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	EP-A-0 233 064 (ALFORM ALLOYS LTD) * column 2, line 41 - line 44; figure 1 *	8	B21C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 JULY 1993	BARROW J.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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